Space Weather Technical Forecast

Issued on Wednesday, 20 March 2024 at 01:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-flares likely (R1-R2 Radio blackouts), slight chance of X-flares (R3 blackouts). Chance of G1 from CME arrivals mainly late Day 1 (20 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate, with the largest flare an M2.1 flare at 19/2327 UTC from AR3615 in the southeast. There are currently eight sunspot regions on the visible disc. The two regions of most interest are in the eastern hemisphere, AR3614 in the northeast (likely ex-3590 from the previous rotation which gave three X-flares) and AR3615 in the southeast. AR3614 has a large main spot with a clear delta configuration, whereas AR3615 has many smaller spots but is showing a couple of small delta regions. AR3616 has remained steady after earlier growth, with a weak beta-gamma configuration. A new spot region, as yet unnumbered, is appearing from around the southeastern limb. The remaining regions currently appear stable or showing slight decay.

No Earth directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds as observed by ACE/DSCOVR at L1 were at ambient levels through much of the period, around 350-380 km/s, but have risen slightly to around 400 km/s since 19/1630 UTC. Density was around average for the start of the period, becoming below average from 19/1513 UTC. Interplanetary Magnetic Field (IMF), Bt, was weak throughout, peaking at 8 nT early on as CME effects waned. The north-south component, Bz, was weak throughout, initially southward directed but then varying weakly, ranging between -7 and +5 nT. Phi angle varied at first, becoming positive (away from the Sun) between 19/0900-1515 UTC, and then switching to negative (towards the Sun) after that. Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux has continued dropping back close to background levels after the S1 enhancement on 15-16 Mar. High energy electron flux (greater than 2MeV) observed at GOES16 was at background levels. The observed 24-hour fluence was below the Active threshold, with a value at 20/0001 UTC of 1.03e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely with a slight chance of becoming High with any isolated X-flares, mostly due to AR3614 and AR3615, but regions in the west still bear keeping an eye on.

Solar Wind / Geomagnetic Activity: A complex filament eruption on 17 Mar saw two possible Earth-directed CMEs. The arrivals of these are expected during the latter part of Day 1 (20 Mar) or into early Day 2 (21 Mar), perhaps arriving as two separate shocks but may also arrive together. The more likely impact is from the slower of the two CMEs, but perhaps also a glancing blow from the slightly faster and further south CME. Ongoing effects are possible during Day 2 (21 Mar), before then easing. Aside from the CMEs, no other sources of notable enhancement to solar winds are forecast.

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Geomagnetic activity is expected to be Quiet to Unsettled (Kp1-3), with a chance of Active or G1/Minor Storm conditions (Kp4-5) late on Day 1 into Day 2 from the filament eruption CME from 17 Mar. Effects are then likely to decline through Day 2, becoming largely Quiet by Day 3 (22 Mar) in the absence of further CMEs.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux at GOES18 is expected to remain around background levels, with a slight chance of further enhancements. This risk increases slightly through the period as AR3614 and AR3615 rotate towards centre disc. High energy electron flux (greater than 2MeV) is expected to persist at mainly background levels with the associated 24 hour fluence remaining below the Active threshold.

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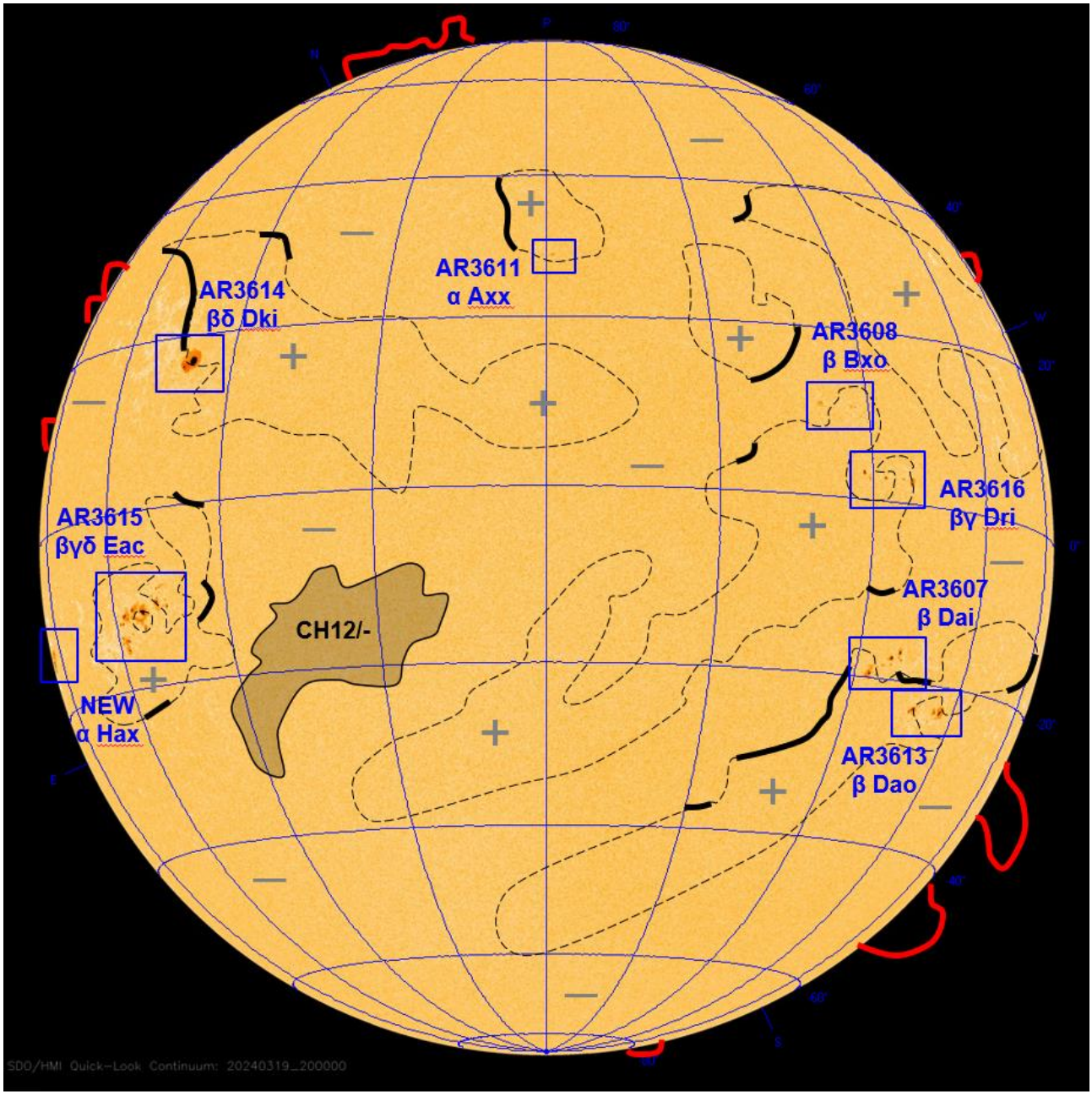
Figure 1. Solar Analysis Valid 19/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is the very low possibility of a glancing CME interaction early on Day 1 (20 Mar), although this may have already arrived as a very weak and transient feature on 19 Mar.

A more notable CME was observed from a filament eruption from the southeast disc, occurring near AR3613 at around 17/0230 UTC. This is a complex eruption, splitting into two separate CMEs. The first one went to the southeast, and is faster, narrower but brighter on imagery, possibly giving a glancing impact during the evening of Day 1 (20 Mar). The second to the southwest is fainter, slower and wider, and consequently more likely to be observed arriving at Earth and is also expected later on Day 1, with ongoing effects possible into Day 2 (21 Mar), before then easing.

Aside from the CMEs, no other sources of notable enhancement to solar winds are forecast, with no coronal hole influences expected during the forecast period.
Geomagnetic activity is expected to be Quiet to Unsettled, with a chance of Active or G1/Minor Storm conditions late on Day 1 and into Day 2, in association with the filament eruption CME from the 17 March. Effects are then likely to decline later through Day 2, becoming largely Quiet for Days 3-4 (22-23 Mar) in the absence of further CMEs.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	30	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/1035	Partial	Filament	SW, near AR3613	505	20/2000	Limited shock expected. Moderate confidence. Perhaps preceded by glancing blow.

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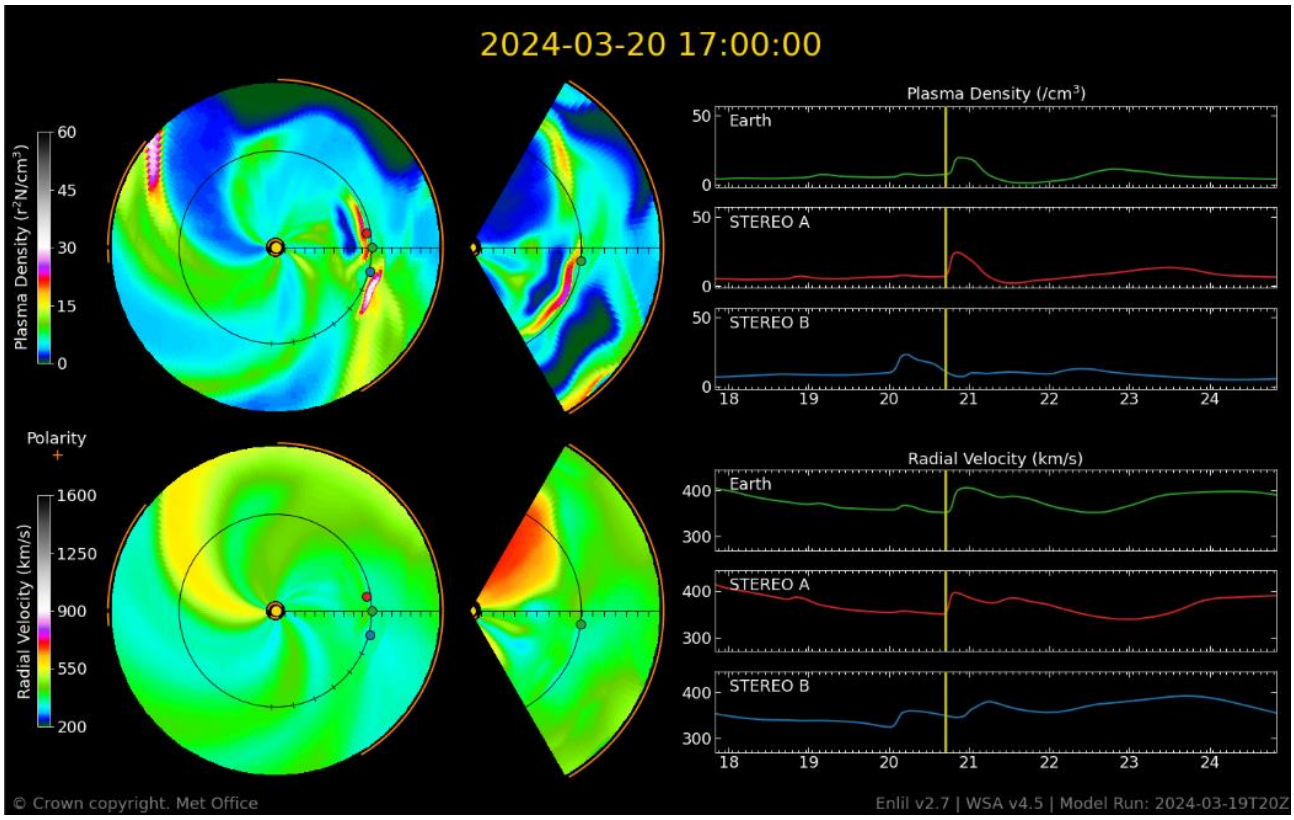
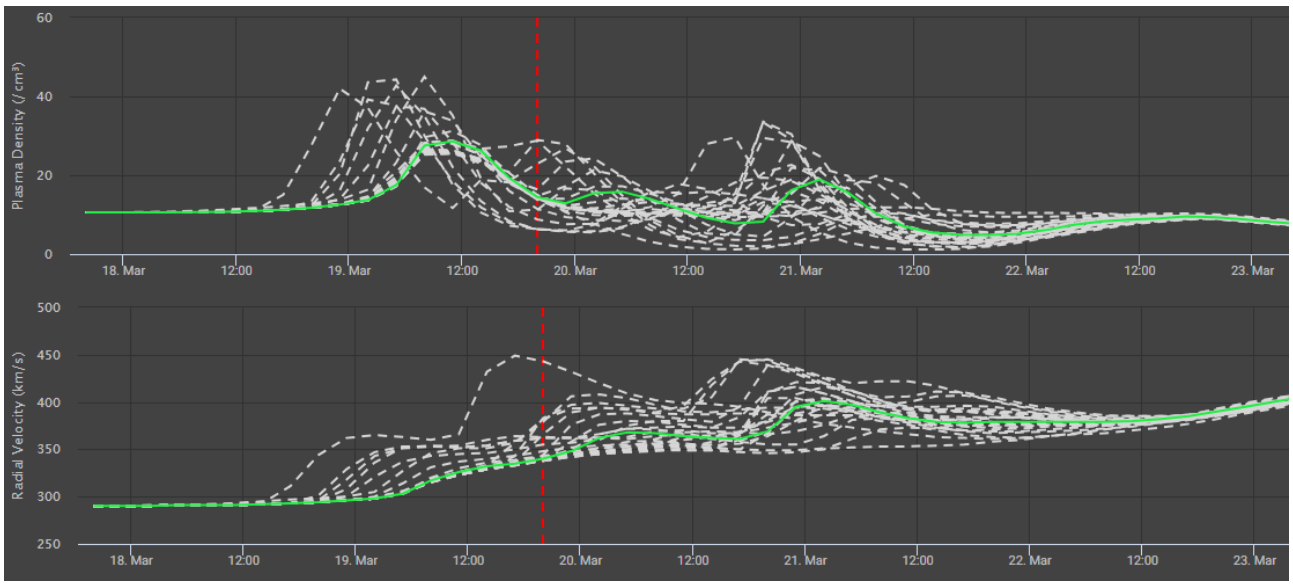
Figure 2: MOSWOC Enlil and ensemble, showing the main CME arrival late 20 Mar.





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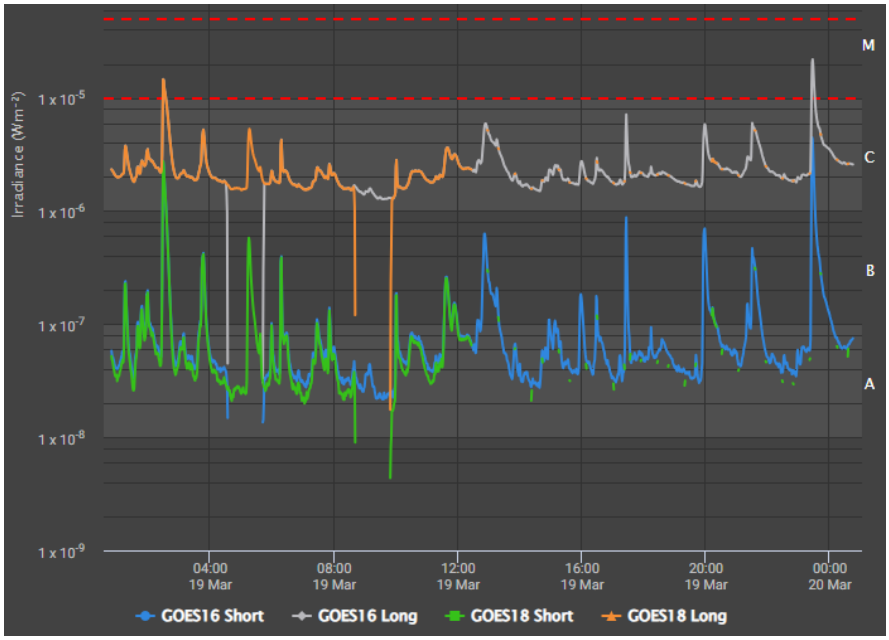
Radio Blackouts - X-Ray Flares:
Activity has been Moderate, with the largest flare an M2.1 peaking at 19/2327 UTC from AR3615 in the southeast.

There are currently eight sunspot regions on the visible disc. The two regions of most interest are AR3614 in the northeast (likely ex-3590 from the previous rotation which gave three X-flares, including X6.3 the largest of the solar cycle so far) and AR3615 in the southeast. AR3614 has a large main spot with a clear delta configuration, whereas AR3615 has many smaller spots, but is showing a couple of small delta regions. AR3615 has continued to show growth in the last few hours and has been responsible for the majority of recent flares, including two M-class. AR3607 has slightly simplified in recent hours, with some penumbra fading. AR3616 in the west developed rudimentary penumbra and a weak beta-gamma configuration but has remained stable recently. A new spot region, as yet unnumbered, is appearing around the southeastern limb and will continue to be re-analysed as it rotates further onto the visible disc. The remaining regions currently appear stable or showing slight decay.

Moderate activity is considered likely with a slight chance of becoming High with any isolated X-flares, mostly due to AR3614 and AR3615, but with some complexity in other regions suggesting these are worth watching too.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES16/18 X-ray flux.



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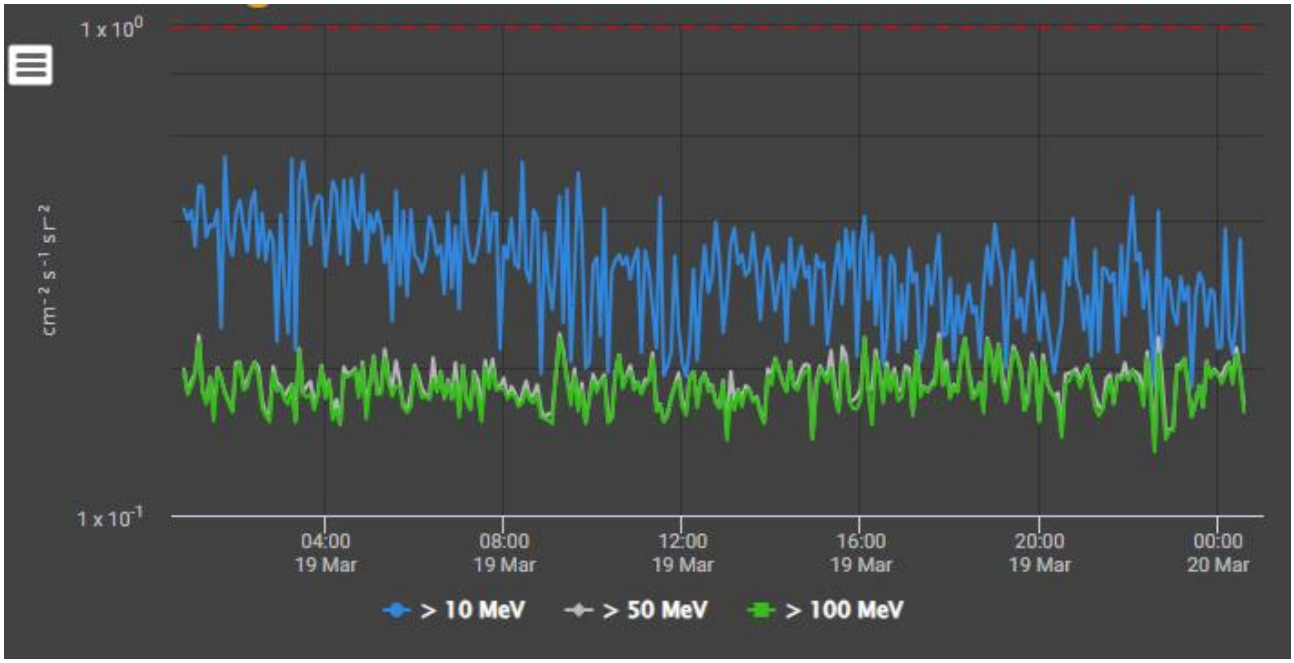
Solar Radiation Storms - (High Energy Protons):
High energy proton flux, as observed by GOES-18 is currently just above background levels after falling since the S1 event on 15-16 Mar. Flux is expected to remain at or close to background over the next couple of days, with further enhancements unlikely. As AR3614 and AR3615 rotate towards centre disc through the period, they move into a slightly better location for proton events to reach Earth and the probability of reaching S1 rises a little.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES18 Proton flux.



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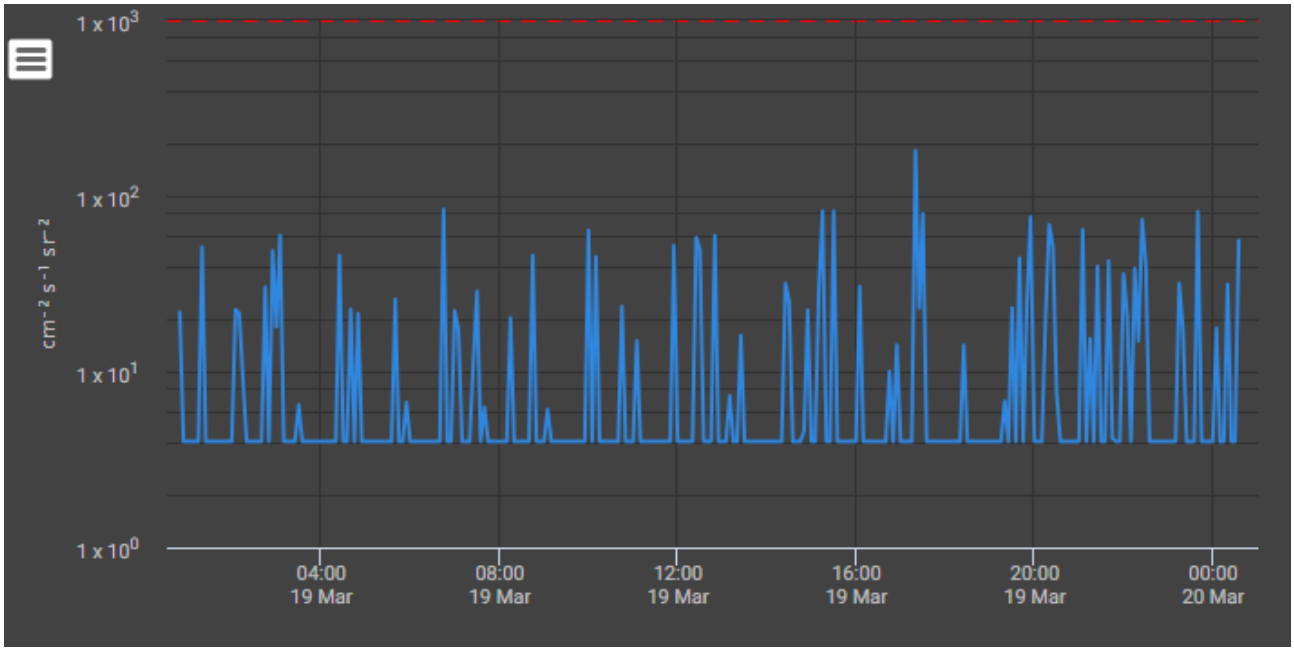
High Energy Electrons Event (≥ 2MeV):
GOES-16 electron flux is expected to remain at mostly background levels, with no significant sources of enhancement expected. A CME arrival is probable late on Day 1 (20 Mar) and into Day 2 (21 Mar), however this isn't expected to have a large geomagnetic impact at Earth. After the CME influence eases off a rise in electron flux is probable as the van Allen belts expand back out again, but unlikely to be significant.

As a result, the associated 24 fluence is expected to remain below the Active threshold, albeit with a very slight rise in probability later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES16 Electron flux.



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